



## Physico Chemical and Sensory Evaluation of the Fortified Biscuits with Sesame Cake Flour

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### Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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### ABSTRACT

Sesame (*Sesamum indicum*, L.) is the main important crop, edible oil source and protein in Saudi Arabia. In the present study, wheat flour supplemented with sesame cake flour (SCF) at different levels of substitution 20%, 30% and 40% for biscuits making. Biscuits sensory evaluation was carried out using 10-points hedonic scale. The results concluded that, 20% sesame flour substitution was the best one of sensory characteristics of biscuits as colour, taste, appearance, flavour, texture and overall acceptability. In addition, the protein, crude fat, fiber, ash of the composite biscuit showed increases while the carbohydrate and moisture contents exhibited decreases in content. The mineral elements content of the composite biscuit increased significantly ( $p < 0.05$ ) with increased sesame flour substitution. Composite biscuit with the 40% biscuit exhibiting the least preference. Therefore, sesame flour inclusion in biscuit making has the ability to improve the physicochemical and micronutrient content of the composite samples.

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## 1. INTRODUCTION

The food fortification now is considered the main interests of nutritionists to meet the nutritional consumer's awareness [1]. Today's, the consumer target are increasingly toward healthy food choices with healthy benefits, such as enhancing the physical body functions or reducing the diseases risk [2]. Biscuits are widely consumed between children with good taste and price. It is easily to fortified with different types of micronutrient such as proteins, vitamins and minerals to provide convenient food [3].

Sesame (*Sesamum indicum*, L.) is one of economically crop cultivated in Makkah and Gizan regions of Saudi Arabia [4], and can be recast its cake flour as a good source for the fortification for different types of foods [5]. Sesame seeds are rich with oil and protein, it contains 50% oil, 25% protein and rich in vitamins A, B complex and E, minerals like phosphorus, calcium, iron, magnesium, copper, potassium and zinc, while white sesame seeds are rich in iron and high content of linoleic acid. [6-8]. Also, after extraction of oil, the by-product SCF is a good source of nutrients and proteins with high contents of methionine and tryptophan [9]. This meal or cake has high alternative use as ingredients or protein source food industries spatially in dough as biscuits, bread, and cakes [10]. Therefore, the present study had undertaken to produce a biscuit supplement with SCF and evaluate its chemical composition, physical properties and sensory characteristics.

## 2. MATERIALS AND METHODS

### 2.1 Materials

Sesame seeds were cultivated in Jizan area, Saudi Arabia, wheat flour and baking ingredients were purchased from local market. Chemicals and reagents were analytical grade.

### 2.2 Solvents Extraction of Sesame Cake Flour

This work was performed at the Food Technology Research Institute, Agricultural Research Center, Cairo, Egypt. According to the method described by Manal, [11]. Sesame seeds were manually cleaned to removing all foreign matter such as dirt, broken seeds and stones.

Seeds were drained on a sieve, soaked in water for one hour and roasted at 200°C for 15 min using an electrical drying oven Model D-63450, Hanau (Germany). Sesame samples were crushed in a mortar before analysis. 150 g were placed in one liter dark flasks and homogenised with 750 ml hexane and the mixture was stirred overnight. The extract was evaporated using a rotary evaporator at 40°C then the obtained oil was taken for further investigation. Sesame cake is obtained as a byproduct after oil extraction is powdered and converted into meal or cake flour [12].

### 2.3 Preparation of Biscuits

The dough of each blended flour was sheeted to 3 mm thickness by Atlas Brand Rolling Machine. The dough was cut into round shape using a 45 mm diameter cutter, baked in aluminum tray and cooked in the electric oven at 180°C for 6 minutes. The biscuit was cooled for 30 minutes, packed and stored in polyethylene bags for further investigation [13].

### 2.4 Physical Properties of Biscuits

The physical properties of biscuit as width (cm), height (cm), spread ratio and spread factor were evaluated. Ten of the tested biscuits were used for the evaluation and the averages were recorded.

### 2.5 Proximate Analysis of Ingredients and Biscuit Samples

The moisture, fats, crude protein, ash and fiber contents of the composite biscuit were determined according to method of AOAC [14]. Carbohydrate was determined according to the equation:

$$\text{Carbohydrate} = 100\% - (\% \text{moisture} + \% \text{fat} + \% \text{protein} + \% \text{crude fiber} + \% \text{ash}).$$

### 2.6 Mineral Composition

The elements of Mn, Ca, Cu and Fe were determined by using ICP (ICAP6200) according to the method of Isaac and Johnson [15]. K, and Na were estimated using Flame Photometry (Jenway PFP7) while, P was estimated by using Atomic Absorption 906A [16].

## 2.7 Sensory Evaluation of Biscuit Samples

The sensory evaluation of biscuits such as color, taste, texture, odor and overall acceptability were done by ten expertize volunteers. A numerical hedonic scale ranging from 1 to 10 was used, 1 is very bad and 10 is excellent [13].

## 2.8 Determination of Amino Acids Composition

The SCF amino acids composition was determined by using amino acid analyzer (Biochrom 30) according to the method of Youssef [17]. Samples were digested with 25 ml of 6N HCl at 110°C for 24 h. HCl was removed by evaporation, the precipitate was dissolved with 0.2N sodium citrate buffer (pH 2.2). One ml of the solution was filtered through 0.45 µm and used for further analysis. Seventeen amino acids were used as standard; the resulted peaks of amino acids were expressed as g/100 g protein on dry weight basis.

## 2.9 Statistical Analysis

The results of organoleptic evaluations were evaluated by an analysis of variance and least significant difference (LSD) was calculated.

## 3. RESULTS AND DISCUSSION

### 3.1 Chemical Composition of Ingredients

The chemical composition of wheat flour and sesame cake flour are given in (Fig. 1). In general, (SCF) contain high levels of protein, ash, crude fiber and fat content as compared to wheat flour.

The protein, fat, ash and fiber contents of SCF were 43.25%, 49.55%, 13.06%, 7.28% respectively. While, low values of carbohydrates and moisture contents in SCF than wheat flour which represented by 36.41% and 4.26% respectively. The moisture value was almost the same reading finding by Zebib et al. [18] and Akinoso [19], who had reported moisture content of 3.75 and 4.81% for sesame respectively. Anilakumar et al. [20] reported that, the sesame protein content was 18.3%. This difference in protein content could be due to the sesame variety, storage condition and growing climate environment. The fat content was 49.55%, this result is slightly higher than the finding by Akinoso [19] who reported 47.73% of sesame fat content.

### 3.2 Mineral Composition of Ingredients

Data presented in Table 1 show, SCF had a high concentration of calcium, magnesium, Zinc, Iron, phosphorus and potassium which recorded by 1200.02, 185.71, 3.8, 10.6, 580.52 and 374.71 mg/100 g respectively. These results are agreement with the finding of Tesfaye et al. [21] who reported that, Magnesium, Zinc, calcium, potassium and phosphorus content of sesame was 342.78, 5.23, 1111.61, 476.64 and 352.68 mg/100 g, respectively and low value of iron content (8.33 mg/100 g).

### 3.3 Amino Acids Composition of SCF

Table 2 indicates that the essential amino acids; leucine, isoleucine, methionine, lysine, phenylalanine, cysteine, threonine, tyrosine tryptophan and valine were found to be 1470, 2690, 1150, 1240, 1000, 1820, 1420, 1720, 1730 and 550 mg/g dry weight respectively.

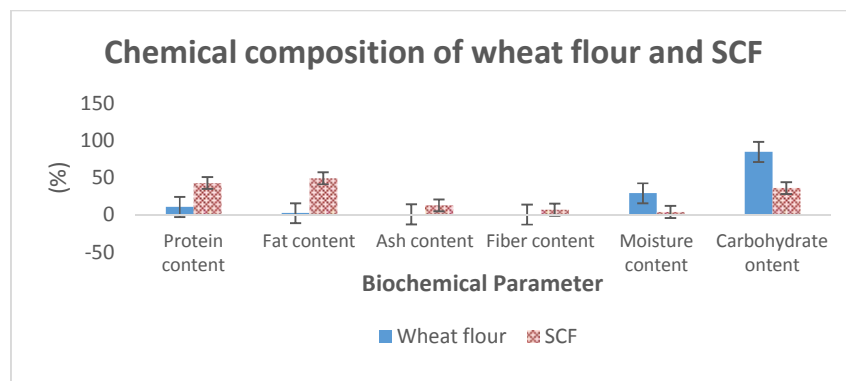


Fig. 1. Chemical composition of wheat flour and SCF

**Table 1. Mineral contents of wheat flour and SCF**

Types of raw materials	Minerals (mg/100 g)					
	Mg	Zn	Ca	Fe	P	K
Wheat flour	130.18±3.04	2.07±0.27	35.48± 0.81	3.08± 0.28	321.95±3.86	362.24±4.67
SCF	185.71±0.20	3.8±0.35	1200.02±1.14	10.6± 0.11	580.52±3.39	374.71±2.17

Values are mean ±SD of triplicate independent analysis.

**Table 2. Amino acids contents of SCF**

Essential amino acids	(mg/100 g dry weight)	Non-essential amino acids	(mg/100 g dry weight)
Isoleucine	1470	Aspartic	4180
Leucine	2690	Serine	1920
Lysine	1150	Glutamic	9220
Methionine	1240	Proline	8320
Cysteine	1000	Glycine	2050
Phenylalanine	1820	Alanine	1930
Tyrosine	1420	Arginine	5160
Threonine	1720	Histidine	1050
Valine	1730	---	---
Tryptophan	550	---	---

The data in Table 2 also indicate the non-essential amino acid glutamic reached to maximum value 9220 mg/100 g dry weight for the sesame cake extracted by solvents and followed it by non-significant difference the amino acid proline 8320 and then with significantly decreased in arginine, aspartic, glycine, alanine, serine and histidine which represented by 5160, 4180, 2050, 1930, 1920 and 1050 respectively. Similar types of results has been published previously by Ramachandran et al. [22] who observed that, the sesame cake is rich with high contents of some of amino acids as methionine, tryptophan, cysteine, lysine, phenylalanine, arginine and glycine. On the other hands, Namiki [23] reported the protein in sesame seeds has low amino acids contents especially lysine which represent by 21 mg/g protein and high in methionine, cysteine, arginine and leucine represented by 36, 25, 140 and 75 mg/g protein respectively. And this maybe back to the types of soil, varieties, fertilisation factors, types of seeds and extraction methods.

### 3.4 Chemical Composition of Biscuit

The chemical composition of biscuit made from the substitution of wheat flour with 20, 30 and 40% of SCF are given in Table 3. It was observed that protein, fiber, fat and ash contents increased by increasing the substitution level of SCF compared to control sample, this may be attributed to high protein, fiber and fat content in sesame seeds. On the other hands,

carbohydrates content was significantly decreasing by increasing the substitution levels. Furthermore, the results indicated that 40% SCF had the highest content of protein, fats, fiber and ash (16.60, 16.95, 8.20 and 4.15 g/100 g dry weight respectively) relative to other biscuit samples. The study of the chemical composition of biscuit back to the importance of the fortification with different levels of sesame flour to increase the nutritional values of the final product [24]. These results are in agreement with Gandhi and Srivastava [25] who reported that the fortification of bread with 10%, 15%, 20% and 25% with sesame cake lead to increase in protein, fiber, fats and ash content, however, other studies reported, low value of substitution with sesame cake lead to non-significant increase in the chemical composition of the final product [26].

### 3.5 Mineral Composition of Biscuit

The data indicated in Table 4 show increasing contents of calcium, iron and zinc by increasing levels of fortification with sesame cake. Calcium was significantly increased from 82.02 to 128.13 mg/100 g dry weight with increasing the fortification from 20% to 40% of SCF. While, iron and zinc were lower than calcium in their contents, the iron changed from 1.55 to 3.21 and zinc from 1.65 to 2.92 mg/100 g dry weight of 20% and 40% substitution respectively. These results were agreements with results of Elleuch et al. [27] who reported that increasing of some elements in the sesame cake after extraction and

this lead to increasing in mineral contents of the biscuit after fortification. The proximate composition of sesame seeds indicates that it has significant amounts of proteins that can be used to produce composite flour with improved protein content for biscuits production [28,29].

### 3.6 Physical Properties of Biscuit

The effect of SCF substitution levels on biscuit quality is shown in Table 5. It is evident that the diameter and thickness of biscuits prepared by reaching sesame cake flour up to 40% level were slightly increased with increasing of SCF substitution percentage and lower than in the control sample. The results agree with work done by Hussain et al. [30] who found that diameter and thickness of flaxseed cookies showed gradually increase as the level of flaxseed flour substitution. Moreover, the results of spread ratio of biscuit revealed a reduction in spread ratio from 9.33 to 8.21 cm. It is clear that as the sesame cake flour level increased, spread ratio for different treated biscuits gradually decreased. These results are on the line with the findings of Ganorkar and Jain [31] who found that the reduction in spread ratio maybe be due to increase in dietary fiber and protein.

### 3.7 Organoleptic Characteristics

The organoleptic characteristics of biscuit made from wheat flour fortified with different levels of SCF such as color, appearance, taste, odor, texture and overall acceptability are indicated in Table 6. There was no significant difference in all sensory properties of biscuit except taste score

between control and those blends which contained 40% of SCF. The results showed that as the sesame cake levels increased, all of sensory attributes scores decreased and the color of biscuits become darker compared with control. Furthermore, biscuits containing 25% SCF showed maximum sensory scores compared to other samples and non-significantly difference with control biscuit. However, 40% substitution, the product becomes less acceptable to the consumer. The results were similar with the results obtained by Moraes et al. [32] who found that acceptance of flaxseed, as a dietary ingredient of functional food in cakes, revealed consumer acceptance up to 30% supplementation level. Eisa [33] reported that, the texture is an important factor of comparing the biscuit as it greatly affects consumer acceptance of the product. Where, Masoodi and Bashir [34] found that the color of the fortified biscuits attained more dark color as the flaxseed and sesame supplementation was increased. However, the texture was slightly decreased with supplementation but described no undesirable change.

The overall quality of the biscuits was significantly reduced by addition of sesame cake flour compared with control. This may be due to the concentrated sesame flavor, dark brownish color, nonacceptable taste, rough surface, gritty mouth feels and, less crisp making them to score low in sensory evaluation [35]. Furthermore, sesame seeds can be used to improve the nutritive value of bakery products as well as for improving sensory properties [36].

**Table 3. Effect of supplementation with SCF on chemical composition of biscuits**

	Control	SCF substitution level		
		20%	30%	40%
Moisture	3.70±0.180	3.67±0.110	3.75±0.140	3.56±0.060
Protein	7.46±0.110	11.92±0.140	14.22±0.081	16.60±0.150
Fats	15.85±0.120	16.72±0.220	16.84±0.110	16.95±0.230
Carbohydrates	73.41±0.229	64.03±0.391	58.97±0.634	54.10±0.392
Fiber	1.94±0.110	4.46±0.310	6.88±0.440	8.20±0.300
Ash	1.35±0.08	2.87±0.110	3.10±0.120	4.15±0.200

**Table 4. Effect of supplementation with SCF on mineral contents of biscuits**

Minerals (mg/100g)	Control (wheat flour 72%)	SCF substitution level		
		20%	30%	40%
Ca	20.51±0.76	82.02±0.44	89.26±1.38	128.13±1.64
P	224.06±3.65	248.20±1.21	267.15±2.30	298.10±0.38
Mg	74.40±3.40	120.91±3.74	135.91±2.70	149.38±1.77
Fe	0.92±0.04	1.55±0.15	2.93±0.41	3.21±0.06
Zn	0.77±0.036	1.65±0.14	2.59±0.16	2.92±0.21
K	178.3±0.87	223.42±3.01	280.06±0.47	391.0±14.2

**Table 5. Effect of supplementation with SCF on physical characteristics of biscuits**

	<b>Weight (gm)</b>	<b>Thickness (T) (cm)</b>	<b>Diameter (D) (cm)</b>	<b>Spread ratio (D/T)</b>	<b>Volume (cm<sup>3</sup>)</b>	<b>Relative volume (cm<sup>3</sup>/gm)</b>	<b>Relative weight (gm/cm<sup>3</sup>)</b>
Control	11.75±0.340	0.86±0.080	5.50±0.130	6.39±0.02	19.0±0.400	1.62±0.041	0.62±0.016
20%	10.56±0.240	0.75±0.15	5.91±0.306	9.33±0.09	20.50±0.050	1.94±0.46	0.52±0.013
30%	9.56±0.110	0.70±0.050	5.50±0.120	8.43±0.12	18.00±0.150	1.88±0.038	0.53±0.011
40%	10.90±0.200	0.75±0.012	5.70±0.100	8.21±0.41	18.4±0.200	1.69±0.043	0.59±0.015
LSD	0.447	0.091	0.345	0.647	0.079	0.082	0.026

**Table 6. Effect of supplementation with SCF on sensory evaluation of biscuits**

	<b>Appearance (10)</b>	<b>Color (10)</b>	<b>Internal texture (5)</b>	<b>Particle distribution (5)</b>	<b>Taste (10)</b>	<b>Odor (10)</b>	<b>Overall acceptability (50)</b>
Control	9.75±0.42	9.50±0.55	4.83±0.4	4.88±0.45	9.83±0.40	9.83±0.40	48.91±0.66
20%	9.75±0.42 <sup>a</sup>	9.50±0.55 <sup>a</sup>	4.83±0.4 <sup>a</sup>	4.88±0.45 <sup>a</sup>	9.83±0.40 <sup>a</sup>	9.83±0.40 <sup>a</sup>	48.91±0.66 <sup>a</sup>
30%	9.66±0.52 <sup>a</sup>	9.66±0.82 <sup>a</sup>	4.50±0.83 <sup>a</sup>	4.67±4.152 <sup>b</sup>	9.50±0.54 <sup>a</sup>	9.66±0.52 <sup>a</sup>	47.83±2.60 <sup>a</sup>
40%	8.66±0.82 <sup>b</sup>	9.75±0.10 <sup>b</sup>	4.16±0.98 <sup>b</sup>	4.13±4.190 <sup>b</sup>	8.50±0.54 <sup>b</sup>	8.66±0.52 <sup>b</sup>	43.00±1.41 <sup>b</sup>

#### 4. CONCLUSION

This study concludes that sesame flour supplementation up to 40% improve the nutritional properties of biscuit whereas sensory evaluation was found highest at 20% substitution.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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